ACTIVATION STUDY WITH SoLID

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1. Activation
   - Schematic
   - Power from Target and Baffle
   - Power on Coil

Schematic

FLUKA

- Many good tools for activation and radiation estimates
- Geometrically limitations in producing more complex geometry (new baffle design)
- Poor estimation for hadron electroproduction in our targets

HOWTO

- Use GEANT4 as a source
- Input manually a source in FLUKA
- Use FLUKA tools and cross sections for energy deposition, activation, etc.

FLUKA activation (from FLUKA presentation)

Input options - *Overview*

Input card: RADDECAY

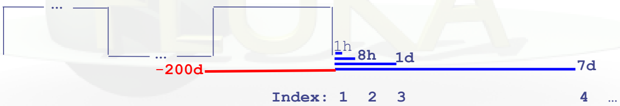
requests simulation of decay of produced radioactive nuclides and allows to modify biasing and transport thresholds (defined with other cards) for the transport of decay radiation

Input card: IRRPROFI

definition of an irradiation profile (irradiation times and intensities)

Input card: DCYTIMES

definition of decay (cooling) times



Input card: DCYSCORE

associates scoring detectors (radio-nuclides, fluence, dose) with different cooling times

Input card: AUXSCORE

allows to associate scoring estimators with dose equivalent conversion factors or/and to filter them according to (generalized) particle identity

FLUKA activation (from FLUKA presentation)

Particle Types

Name	Number	Units	Description
DOSE	228	GeV/g	Dose (energy deposited per unit mass)
DOSE-EQ	240	pSv	Dose Equivalent (AUXSCORE)
ACTIVITY	234	Bq/cm^3	Activity per unit volume
ACTOMASS	235	Bq/g	Activity per unit mass
SI1MEVNE	236	cm^{-2}	Silicon 1 MeV-neutron equivalent flux
HADGT20M	237	cm^{-2}	Hadrons with energy > 20 MeV

FLUKA source (from FLUKA presentation)

Source routine - 3

```
...
      NPFLKA = NPFLKA + 1
* Wt is the weight of the particle
      WTFLK   (NPFLKA) = ONEONE
      WEIPRI = WEIPRI + WTFLK (NPFLKA)
* Particle type (1=proton.....). Ijbeam is the type set by the BEAM
* card
*  +-------------------------------------------------------------------*
*  |  (Radioactive) isotope:
      IF ( IJBEAM .EQ. -2 .AND. LRDBEA ) THEN
         IARES  = IPROA
         IZRES  = IPROZ
         IISRES = IPROM
         CALL STISBM ( IARES, IZRES, IISRES )
         IJHION = IPROZ  * 1000 + IPROA
         IJHION = IJHION * 100 + KXHEAV
         IONID  = IJHION
         CALL DCDION ( IONID )
         CALL SETION ( IONID )
*  |
*  +-------------------------------------------------------------------*
*  |  Heavy ion:
      ELSE IF ( IJBEAM .EQ. -2 ) THEN
         IJHION = IPROZ  * 1000 + IPROA
         IJHION = IJHION * 100 + KXHEAV
         IONID  = IJHION
         CALL DCDION ( IONID )
         CALL SETION ( IONID )
         ILOFLK (NPFLKA) = IJHION
*  |  Flag this is prompt radiation
         LRADDC (NPFLKA) = .FALSE.
*  |  Group number for "low" energy neutrons, set to 0 anyway
         IGROUP (NPFLKA) = 0
*  |
*  +-------------------------------------------------------------------*
*  |  Normal hadron:
      ELSE
         IONID = IJBEAM
         ILOFLK (NPFLKA) = IJBEAM
*  |  Flag this is prompt radiation
         LRADDC (NPFLKA) = .FALSE.
*  |  Group number for "low" energy neutrons, set to 0 anyway
         IGROUP (NPFLKA) = 0
      END IF
*  |
```

increase pointer in FLKSTK

weight of particle (if ≠ 1 biased source)
total weight of primaries (don't change)

Definition of particle type

- The template sets the type of particle equal to the one defined by the BEAM card (and HI-PROPE, if used).

- Whichever valid particle type can be set inside the source (may be different event by event)

Plan

What I am planning (open to discussion)

- Use GEANT4 as a source and background estimation
- Build a graphical database to better understand the weights of different process for Activation (FLUKA) see for example Link to Shielding study
- Use FLUKA to fully estimate the activation and radiation estimates

Deuterium target ... Aluminum baffle

Energy distribution on first baffle

The following plots show:

Energy Flux on first baffle	$(\Leftarrow)$ + vertex from TG
Energy deposited in first baffle	$(\Leftarrow)$ + vertex from TG

Deuterium target ... Aluminum baffle

Energy distribution on first baffle

The following plots show:

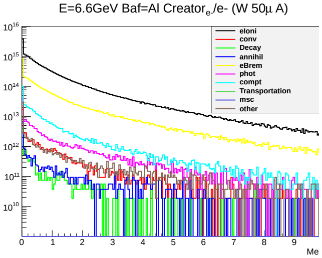
Energy Flux on first baffle	$(\Leftarrow) +$ vertex from TG
Energy deposited in first baffle	$(\Leftarrow) +$ vertex from TG

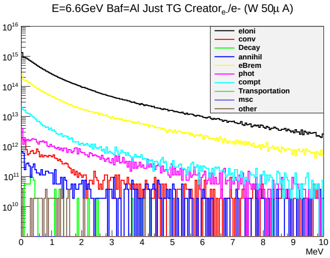
Processes

Processes are:

- Creator process for Flux
- Depositing process for Energy deposited

Electron


E=6.6GeV Baf=Al Creator$_{e-}$/e- (W 50µ A)
eloni
conv
Decay
annihil
eBrem
phot
compt
Transportation
msc
other
Me


E=6.6GeV Baf=Al Just TG Creator$_{e-}$/e- (W 50µ A)
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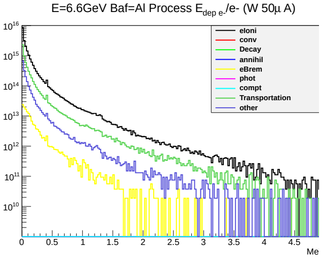
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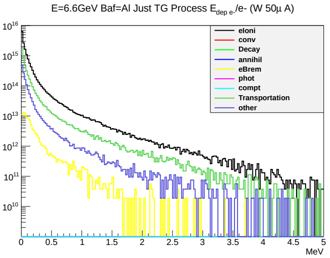
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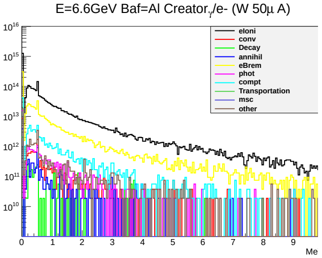
Gamma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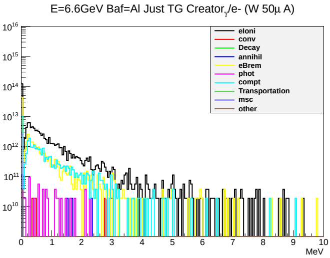
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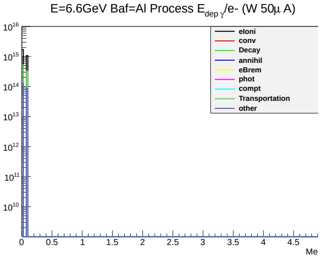
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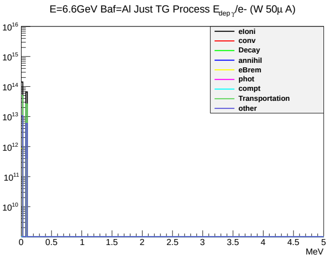
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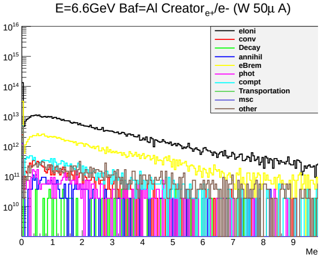
Positron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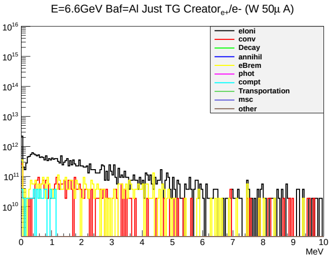
E=6.6GeV Baf=Al Just TG Creator$_{e+}$/e- (W 50µ A)
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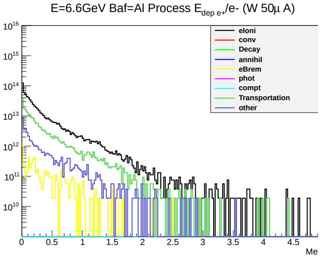
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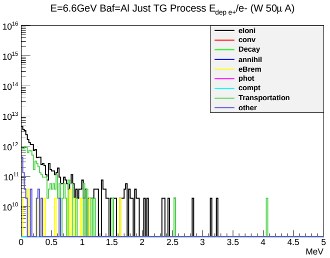
E=6.6GeV Baf=Al Just TG Process E$_{dep\ e+}$/e- (W 50µ A)
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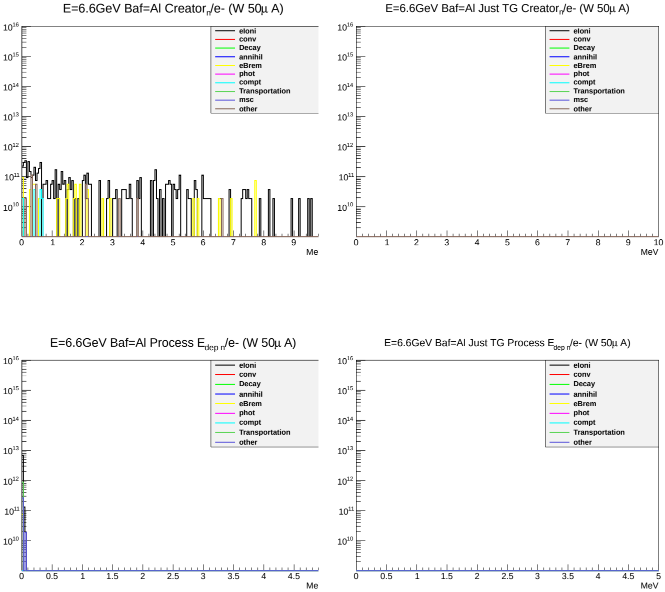
Neutron


E=6.6GeV Baf=Al Creator$_n$/e- (W 50µ A)
E=6.6GeV Baf=Al Just TG Creator$_n$/e- (W 50µ A)
E=6.6GeV Baf=Al Process E$_{dep\ n}$/e- (W 50µ A)
E=6.6GeV Baf=Al Just TG Process E$_{dep\ n}$/e- (W 50µ A)
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Power on Coil from Neutron

PROBLEMS

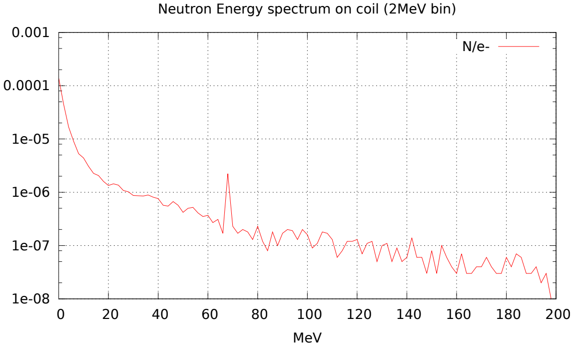
- Radiation on coil dominated from PVDIS config and LD2 target
- FLUKA has really good estimates for neutron interaction, but does a poor job on neutron electroproduction on LD2
- GEANT4 will need to have a user hitclass for neutron energy deposited, but does a good job in producing neutrons

HOWTO

- Use GEANT4 as a source
- Input manually a source in FLUKA
- Use FLUKA tools and cross sections for energy deposition, activation, etc.

Power on Coil from Neutron

Neutron energy spectrum per electron on coil (from GEANT4)

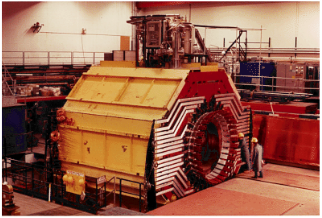


Power on Coil from Neutron

The Superconducting Coil

The CLEO II superconducting coil provides a uniform 1.5 Tesla magnetic field parallel to the beam line over the full volume of the inner tracking, time-of-flight, and calorimetry systems.

The coil was designed and built by Oxford Instruments, Ltd., and delivered to Cornell in July of 1987. It has an inner diameter of 2.9 meters, and the coil is 3.5 meters in length. The coil itself is wound from 5 mm x 16 mm aluminum stabilized superconductor, which is cooled by a liquid helium refrigeration system, utilizing the stable, self-regulating *thermosyphon* circulation flow system.



Shown here is the CLEO II detector about halfway through the assembly process. The outer surfaces in the photograph are the first few layers of iron shielding, and the stainless container on top of the detector is a liquid helium storage dewar and instrument pack.

Power on Coil from Neutron

Energy deposited by Neutron in the coils

- Total energy deposited in the coil $\sim 3KeV/e^-$
- At $50\mu A$ translates to $\sim 0.16W$